IV. "Observations made on the Movements of the Larynx when viewed by means of the Laryngoscope." By JOHN BISHOP, Esq., F.R.S. Received June 5, 1862.

I had not contemplated any further investigation on the physiology of intonation by the human organs of voice, had not my attention been aroused by the facility afforded by the apparatus of Professor Czermak, of seeing what actually takes place in the larynx during the production of vocal sounds.

The tact of the Professor in applying the instrument in his own case, and the impunity with which he is able to bear its presence in the sensitive parts of the pharynx, are great advantages.

In many persons the presence of any foreign body so applied, usually produces, by reflex action, a sense of sickness in the stomach.

In ordinary breathing the glottis is wide open, and the arytenoid cartilages are thrown wide apart; but on the production of the most simple sound, these cartilages are suddenly and rapidly closed, and the edges of the vocal cords come into juxtaposition with each other so as to leave no interval between them in their entire length.

In the production of the lower tones of the voice the vocal cords may be seen to vibrate throughout their whole length, and even at their prolongations at the base of the arytenoid cartilages; they seem to vibrate also throughout their entire breadth. As the pitch of the tones rises in the scale, the length of the cords in a state of vibration diminishes, and they are pressed more closely against each other: as the tones become more acute, the pressure is increased, and the tension of the vocal cords augmented; the breadth of the cords is also diminished.

When the chest tones have arrived at the limit of the scale of acute range, and the falsetto tones commence, the glottis is seen to be more closely pressed together, and the edges only of the vocal cords are suffered to vibrate, as Garcia has already observed. On the other hand, while the chest tones are produced, a larger surface of the vocal cords is in a state of vibration. When the falsetto tones are produced, it appears that the very extreme edge only of the cord vibrates, and a much less expenditure of breath is required. While the highest notes of the voice are intoned, the vocal cords are so closely pressed together, that a small portion only of the glottis is

seen to yield to the pressure, which takes place nearly at its central portion.

From the inspection of the vocal organs now so easily obtained, it may be stated in general terms that, as the voice ascends from its lowest to its more acute tones, the lengths of the vibrating portions of the vocal cords are proportionally diminished, while at the same time their tensions are increased; and, in fact, they present the same phenomena as those of musical chords, and they appear to obey the same laws, as Ferrein so long since supposed, and which have since been confirmed by Müller and by myself.

Moreover, the vocal cords form a kind of valve, which is situated in a tube, and acts on the column of air in the manner of a reed.

It is observed that while the pitch of the tones of the voice becomes more grave, the epiglottis is depressed and the pharynx is relaxed; and, on the contrary, as the pitch becomes more acute, the epiglottis is raised and the pharynx becomes contracted: the depression of the epiglottis probably assists in deepening the pitch of the vocal tube in the same manner as the lid of an organ pipe does.

In the production and modulation of the voice, it is astonishing with what accuracy some persons are able to produce at will, sounds of a determinate pitch and of a quality which charm and captivate the ear of a musician. The muscles which are principally concerned in this faculty are the thyro-arytenoid and the lateral crico-arytenoid. The crico-thyroid is limited to stretching the vocal ligaments.

The mere turning of the vocal cords on their axes, out of the vocalizing position, does not afford sufficient space for ordinary breathing, as supposed by Mr. Willis, but we find that the arytenoid cartilages and vocal cords are widely separated during ordinary breathing.

With regard to the controversy as to whether the vocal organs are to be considered as a stringed instrument or as a reeded pipe, it has been thought by some physiologists that the same organs cannot possibly perform the offices of both. However, under the denomination of reeded pipes, we find a great variety of form and structure, and it is not difficult to conceive that while the time of an oscillation of the vocal ligaments obeys the same laws as musical strings, the

valve of the glottis in opening and closing the vocal tube performs an action resembling that of some of the musical reeds.

The human organs of voice have been considered by a great many distinguished philosophers as constituting a reeded instrument, and the relation in which they stand to instruments of that character has been already discussed in my paper in the 'Transactions' of the Royal Society for the year 1846; it only remains to remark that the phenomena brought to light by means of the laryngoscope tend to confirm the idea that the vocal organs really perform the double effect both of reed and string.

In ejaculatory sounds, such as the production of the syllables há, há, há in laughing, the glottis is opened at each intermission and closed at each intonation of sound, thus producing a rapid succession of opening and closing the glottis.

In a paper published in the 'Proceedings of the Royal Society*,' by Manuel Garcia, a great number of observations on the movements of the glottis are described; many of these have been verified both by Professor Czermak and by myself, and we cannot but be gratified by the advance which has been made in our knowledge of the action of the vocal organs during intonation, and that the speculations and controversies which have existed on some points are, by the application of the laryngoscope, now brought to a satisfactory conclusion.

The great differences which we find to exist in the quality of the sounds produced—those, for example, of the chest, and those of the falsetto character, the causes of which have excited so much speculation—are in reality effected by very simple changes in the mechanism of the larynx.

It would have been possible to extend this paper by pursuing the inquiry into the details of the special action of the muscles, and the distribution and functions of the nerves of the larynx, as well as the play of the several cartilages, but I have restricted myself to the actual phenomena presented to the eye, and to the acoustic deductions arising out of the movements of the larynx, more especially those of the thyro-arytenoid ligaments.

The waves of sound generated by the larynx in the column of air contained in the vocal tube, set the whole of the membranes surrounding the tube in a vibratory, reciprocating motion, and we know

* May 24, 1855.

from the researches of Savart, and from pathological data, that these movements are essentially necessary to the production of the most simple sounds; for when these membranes are incapable of being put into a state of vibration, the sounds of the voice are extinguished, and the result is aphonia.

V. "Anatomy and Physiology of the Spongiadæ."—Part III. By J. Scott Bowerbank, LL.D., F.R.S. Received June 18, 1862.

(Abstract.)

This paper is the third part of the Anatomy and Physiology of the Spongiadæ. The author, after pointing out the inefficiency, or rather the non-existence of a definite arrangement of species of sponges, proposes to establish a series of orders, suborders, and genera, the distinguishing characters of which are to be founded on the structural peculiarities of the various organs of the animals which have been described in detail and named in the first and second parts of the paper. The term Amorphozoa, proposed by De Blainville as a designation of the class, is rejected, as all sponges cannot be considered as shapeless, many genera and species exhibiting much constancy in their forms, while that of Porifera, proposed by Dr. Grant, is adopted, as the porous mode of imbibition of nutriment is universal in this class of animals. The author also agrees with Dr. Grant in dividing the class into three great orders, dependent on the nature of the substances of which the skeletons are constructed. These three great divisions are designated by Dr. Grant in the following order:—1st, Keratosa, having skeletons of horny structure, with few or no siliceous spicula; 2nd, Leuconida, the skeletons composed of calcareous spicula; and 3rd, Chalinida, the skeletons constructed of siliceous spicula. The author, for reasons stated in detail in the paper, proposes to change the order of this arrangement, placing the calcareous sponges first, under the designation of Calcarea. The siliceous sponges are placed second, and designated Silicea, while the first order of Dr. Grant, Keratosa, is placed last. With these exceptions of arrangement and designation, the orders are essentially those established by Prof. Grant in his "Tabular View of the primary divisions of the Animal Kingdom."